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Energy-Poverty Nexus: Conceptual Framework Analysis of Cooking Fuel Consumption in Ghanaian Households

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Abstract
This paper analysis energy-poverty relation based on household access to energy for cooking in Ghana. The Ghana Demographic and Health Survey data for 2014 was used with multinomial logistic regression. The results show that the so-called energy poverty ladder hypothesis holds for household energy consumption, and wealth status of Ghanaians was found to be a full determinant of household energy adoption for cooking purposes. Generally, a high status household (Middle, Richer & Richest) have an increase in the probabilities of adopting clean fuels (electricity, LPG, etc.) than a poorest home and this is an indication that energy adoption and level of poverty are related. Other variables such as the age of household head, sex of household head, educational level of household head, residence where household stays and the size of household were found to have influence on the energy adoption behaviour of household. Efforts to reduce general poverty should be geared towards, but not limited to, the making of clean fuels available to households and individuals.
Keywords: Cooking fuel consumption; Energy-poverty nexus; Ghana; Household.
JEL Codes: O13, P28, Q42

1. Introduction

This study looks at how household energy consumption and poverty are related. Motivated by the Sustainable Development Goals of UN, Goal 7, which seeks to ensure access to "affordable, reliable, sustainable and modern energy for all". The study look at how household access to energy could lead to reduction in poverty. Several families, homes, or individuals have limited access (deprived) to good energy for household needs. Energy is important for household needs as it forms part of the basic needs of individuals, it helps to provide warm, heat, lighting and cooking of food. A household may be prone to hazardous health implications if it uses traditional forms of energy for cooking, lighting and any other needs (Legros *et al,* 2009). Without clean energy services, women, who most at times cook in the household in developing countries will continue to suffer from a loss of time, hazardous smokes as many of these women spend hours a day walking long distances to collect fuelwood, because they don't have access to clean fuels (Bartels, 2007).

There is a two-way causal relationship between poverty and the lack of access to adequate and affordable energy forms. These is said to be vicious cycle, because poor people who lack access to cleaner and affordable energy are often find themselves in repeated cycle of deprivation, limited incomes and the means to improve their living conditions. They also spend greater amounts of their low incomes on expensive and unhealthy forms of energy that provides poor and unsafe services such as biomass (kerosene lamps, candles, charcoal, firewood, etc.). There is a strong link and negative correlation between energy use and poverty – in so far as no country has managed to substantially increase the rate of poverty reduction without increasing the use of energy usually in the form of electricity (Saghir, 2005).

Poverty is a long-term phenomenon issue and has been the main problem of every economy. More than 700 million people still live in extreme poverty and are struggling to fulfill the basic needs like health, education, and access to water and sanitation (UN SDG's 2014). Poverty can be viewed to be very complex. Many scholars (Bourguignon and Chakravarty, 2003; Alkire and Sarwar, 2009) have acknowledged that income poverty is only one facet (though a very important one) of a multidimensional phenomenon. It is a fact that levels of income and consumption are critical in determining who is poor, but deprivation in basic essential life sustaining needs could better paint the picture of poverty. If one household has better access to healthcare, sanitation, water, educational services and other public services than another household at the same level of income, then the two cannot be said to be equally deprived.

Households that are deprived of their basic life sustaining needs including energy could be considered to be poor. To this end, this study sought to look at nagging issues like; Are those who lack access to clean cooking fuel the poor? Is poverty and household energy consumption related? Does the energy ladder hypothesis hold for Ghanaian households? The remaining of the paper includes; section two looks at the theoretical models of household energy consumption. Section three carries background issues in Ghana with respect to household's energy access and poverty dynamics, while section four looked at empirical literature review and analytical framework this study adopts. Section five is on data and methodology of the study with section six on results and discussions and section seven on conclusions and recommendations.

2. Theoretical Models of Household Energy Consumption

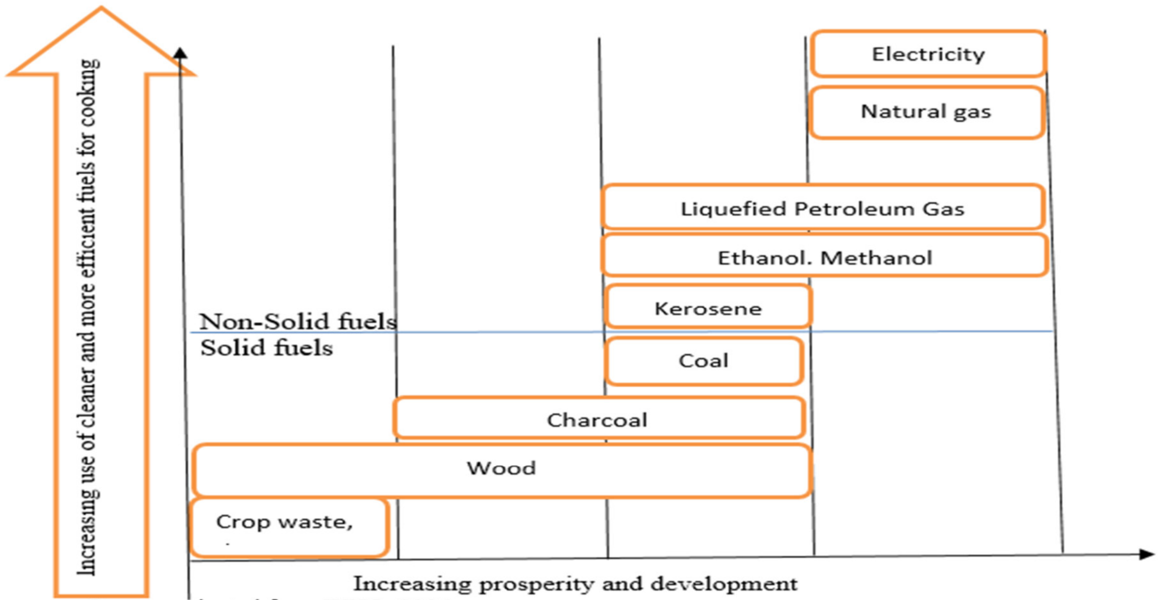
Household fuel consumption analysis is based on microeconomics analysis of consumer behaviour. Becker (1981) noted that, a household can be likened to "a small factory" which combines inputs to produce basic commodities that enter its utility function directly. Many other authors have theoretically studied household energy demand in line with the microeconomics study of consumer behaviour. Rema and Oliva (2013) analyzed data from experiment using simple unitary household model. Where household utility depends on two groups of goods consume, good X (which include clean fuels) and dirty fuel, Qd. Hence, U (X, Qd). Households' faces diminishing marginal utility in both good X and dirty fuel, which both goods can be either complements or substitutes. That is a change in marginal utility for dirty fuel induced by an increase in consumption of good X or a change in marginal utility of fuel induced by an increase in fuel; in other words, households likes a mix of goods. It is assumed households are aware of health damage associated with consuming dirty fuel. Households maximize utility U (X, Qd) subject to constraint of income, capital and labor time. There is wealth effect on dirty fuel, as the marginal utility on consumption decreases with increase in wealth; individuals buy more of dirty fuels. There is substitution effect, which depends on the substitutability or complementarity between consumption of dirty fuel and good X. If they are complements, then increase in consumption of good X, leads to more dirty fuel consumed. If they are substitutes, purchases of dirty fuel reduce.

In standard microeconomics study of consumer behaviour, there is income and substitution effects, but in this fuel consumption case there is third effect, which determines purchasing decisions; i.e. health production function effect and is negative. As income increases individuals are discouraged from consuming health damaging fuels (energy ladder hypothesis as verified by Heltberg, 2003; Ogwumike *et al,* 2014). However, different members in a household have different levels of say in deciding which fuel to consume. Members have different preferences for fuels, as one may like the smoky flavour that comes from cooking with a dirty fuel (firewood etc.) while another dislike that same taste (Akpalu, *et al*, 2013). Also, different members of households may be exposed to dirty fuels in different ways, may be all members are exposed to smoke from kerosene lamp or candle but women are more exposed to smoke from firewood when cooking (Rema and Oliva, 2013) all these are taken in to account when modelling household energy consumption.

There are other authors who proposed more complex agricultural household models or framework which are well fitted for rural households. Rural households, mostly in developing countries, often face absent or incomplete markets for most goods including fuels, agricultural products, labor and credit. If markets work perfectly, rural household may behave as profit maximizing producer, and subsequently utility maximizing consumer. But under market failure allocation of decisions for production and consumption are made jointly in a non-separable fashion. Heltberg *et al*, (2000) considers the market failure for crop residues, animal dung and labour. The author studied the substitution of private non-marketed fuels (animal dung, crop residue) for firewood in response to increase in scarcity of firewood. Chen *et al,* (2006) extended the model by Heltberg by adding missing market for firewood and emphasize substitution between firewood and coal. Mueller and Yan (2014) modelled the links between fuel use decisions with agricultural production, domestic technology, fuel collection technology and rationing of fuels.

2.1 The energy ladder hypothesis

Household energy demand and usage, has most often been examined and explained within the purview of the so-called 'energy ladder hypothesis'. This hypothesis identifies and uses income as a measure or determinant of household fuel consumption, choice and switching behaviour (Heltberg, 2003). That, there is a transition in energy consumption for household needs from traditional biomass (grass, animal dung, firewood, etc.) to modern sources (LPG, kerosene, electricity), with increase in incomes of household or improvement in welfare of households (Rajmohan and Weerahewa, 2009). It serves as a stylized extension of the typical income effect of consumer economic theory that explains how consumers substitute necessary goods and luxury goods for inferior goods as their incomes rises. First stage is where households depend largely on traditional biomass. Such households are mostly the poor or extremely poor, who can barely afford modern fuels. Second stage is where as households or individuals' incomes increases and as urbanization and development takes place, households transit from the consumption of biomass fuels such as wood, grass, animal dung, coal, etc. to a better or somehow clean fuels (like charcoal). Third and final stage is where households begin to use clean modern fuels such as LPG and electricity for cooking and lighting (Heltberg, 2003).



Source: adapted from WHO, 2006

Figure 1: Energy Consumption Ladder

Moving up the ladder is often associated with increasing incomes or stages of economic development. Heltberg (2003) argues that fuel switching is complex as many people use combinations of LPG and wood, wood and kerosene, charcoal and LPG etc. thus both modern and non-modern are used together. Unless distinction is made that all households belong in one of the three 'exclusive fuel switching' type; no switching – those households consume only solid fuels; partial switching – households consume both solid and non-solid fuels; full switching – only non-solid fuels are consumed by households. Critics had it that lower levels of fuels are kept and use simultaneously or as supplement as incomes increases, mainly because of availability and for certain type of cooking needs (fuel for specific task). Kohler *et al* (2009) explains that unreliable supplies require households to rely on different sources of energy and that different energy sources are more cost effective in some uses than in others. It is evident that it is more cost effective to use electricity for lighting and LPG for cooking. Also, in large quantities of cooking it may be cheaper to use firewood than to use electricity or LPG. This is the fuel stacking aspect of the energy ladder hypothesis.

3. Review of Empirical Literature and Conceptual Framework

3.1 Review of Empirical Literature

There is quite a number of empirical literature on household energy access and energy poverty using socioeconomic factors as determinants. Income has been used as a major determinant of household fuel consumption. Ismail (2015) using the economic/expenditure approach she found a positive relationship between energy poverty and expenditures on education and electricity, and a negative relationship with expenditures on food and transport, and size of dwellings of household. As Faisal *et al,* (2013) also concluded that there is positive relationship between charcoal or LPG and income levels, but wood is found to be negative at all income levels. That income has a positive relationship with the consumption of clean fuels (electricity, LPG) and negative relation with 'dirty fuels' (firewood, grass, charcoal etc.) (Aitken 2007; Demurger and Fournier 2007; Mekonnen and Kohlin 2008; Kwakwa and Wiafe 2013). However, by using income/expenditures as the only measure of energy poverty could be bias, because poor households may rely on cheap but inferior biomass for their energy needs. From Kohler, Rhodes and Vermaak (2009), it is explained that given two different households, say 'A' and 'B' in which they all spend 15% of their incomes on energy, then to the income/expenditure approach, both households are deemed as energy poor. Looking at the type of energy consumed, household 'A' may be spending on electricity and 'B' on firewood and candles, then 'A' obtains better energy use, since electricity is more efficient and clean than firewood and candles.

The level of education of the individual is found to have influence on the type of fuel the person adopts for home use. Educational level of household head was found to have a negative association with firewood usage (Abebaw, 2007; Demurger and Fournier, 2007; Tchereni 2013). Nlom and Karimov (2014) modelled fuel choice among households in northern Cameroon and found education to be positively related to adoption of clean fuels as other studies (Ogwumike *et al,* 2014) concluded. Education is positive to fuel use, hence, having access to education increases the probability of using clean fuels (Mensah and Adu 2014). Generally, education of the individual was found to have a positive relation with the consumption of clean fuels (electricity, LPG etc.) and negative to the consumption of 'dirty fuels' (firewood, grass, animal dung, etc.).

Household size is yet another variable found to have an effect on household fuel adoption. The assumption is that a larger household may cook larger quantity of food and thus needs fuel that could be minimum cost in terms of the cooking. Abebaw (2007) found household size to have a positive relationship with firewood consumption but negative to charcoal. Deshmukh *et al* (2014) concluded that the size of household has a negative relation to fuel use. Large households use non-modern fuels (firewood, grass, animal dung, charcoal etc.) and smaller homes has high probability of using modern fuels (electricity, LPG etc.). It is quiet economically and health wise to adopt electricity for lighting for a larger home than to use kerosene or wood and in a similar vein, it is economical to use wood for large or commercial cooking than to use electricity or LPG in most developing countries such as Ghana.

Gender (whether male or female) of an individual is also found by some studies to have influence on the adoption of fuel for home use. Abebaw (2007) found gender (i.e. being male) of household head to be negatively associated with firewood usage which is similar to Kwakwa and Wiafe (2013) that the probability of using firewood has a negative relationship with the variables gender. Ogwumike *et al*, (2014) study indicated that male headed household are likely to use LPG and kerosene for cooking but not firewood than their female counterpart as Deshmukh *et al* (2014) further stated that female headed household reduces likelihood of using modern fuels (electricity, LPG, etc.). Other studies (Mekonnen and Kohlin 2008) affirmed that a female headed household is likely to use solid fuels (firewood, charcoal, grass, etc.) or mixture of solid and nonsolid (LPG etc.).

Residence nature (i.e. where household stays – rural or urban) of household is also deemed to affect the choice of fuel for domestic use. Rural home may have greater access to solid fuels (firewood, charcoal, grass, animal dung etc.) than urban homes. Whilst urban homes have access to clean fuels (electricity, LPG, etc.) than rural homes. Pachauri *et al* (2010) on household energy consumption in India, found that rural population rely heavily on biomass as fuel for cooking, whereas urban population switches from traditional biomass to modern fuels. Urbanisation is found to be inversely related to firewood use and positive of kerosene, LPG and electricity usage for cooking as established by Ogwumike *et al*, (2014). Rural dwellers are more likely to be moderately energy poor relative to being non-poor compared to their urban counterparts (Edoumiekumo *et al,* 2013). This is also established by Karakara and Osabuohien (2018) suggests that urban households have more access to clean fuels than rural households, but this difference is more pronounced in the adoption fuels for cooking than for lighting.

Yet another important variable found to have influence on individual as well as household adoption of energy for home use is the age of the individual. Abebaw (2007) found age of household head to have a positive relationship with firewood consumption but negative to charcoal, but in a sharp contrast, Kwakwa and Wiafe (2013) showed that the probability of using firewood has a negative relationship with the variables, age, and age squared. Similar to the latter, Mensah and Adu (2014) concluded that age of the household head has a negative effect on the probability of using clean fuels over inefficient fuels. Also, Awan *et al,* (2014) concluded that in the rural setting, 71.4% and 28.6% of the households in Pakistan are energy poor and non-poor respectively. Generally, there have been variant findings on the relationship between age of an individual and fuel type adoption, a positive relationship is found between age and clean fuel adoption (Onoja and Idoko 2012), a negative relation between age and clean fuel (Edwards and Langpap, 2008; Nlom and Karimov (2014), a negative relationship between dirty fuel and age (Tchereni 2013) and a positive relation between age and dirty fuel (Mekonnen and Kohlin 2008; Deshmukh *et al*, 2014; Ogwumike *et al,* 2014).

Other studies have found other variables such as; marital status of household head, asset ownership and dwelling ownership to have an effect on energy adoption for household needs. Marital status (i.e. being married) is found to have a positive effect on adopting clean fuels (Tchereni 2013; Karakara and Osabuohien, 2018). Abebaw, (2007) found home ownership to be consistent with using clean fuel (i.e. charcoal in this case), similar to this is Deshmukh *et al*, (2014) conclusion that Dwelling ownership have a positive association with fuel use. Where household owns the apartment there is increase in the likelihood of using modern fuel.

From the forgoing empirical literature, it can be deduced that socioeconomic variables are, to a much extend, determinants of household energy consumption. These same variables are found by other studies (Phillip and Rayhan, 2004; Jha and Dang, 2009) to have influence on the wealth status or poverty level of individuals or households. A wealthier home, with much educated persons, staying in urban area, owning the dwelling they live in and having access to assets, all things being equal, could been deemed to be a richer home and will most likely adopt clean fuels (electricity, LPG, etc.) for their household needs than their reverse counterparts. Access to clean energy and poverty are to some extend intertwined and may not be separated. This is explained more by the conceptual framework this paper adopts, which is in figure 2.

3.2 The Conceptual Framework

In figure 2, the conceptual framework is explained in it. Using six socioeconomic indicators (residence, income, education, gender, household size & age) of the individual or household (in this case household head) to explain how changes in this indicators (variables) links energy and poverty in the energy-poverty literature. In the figure,

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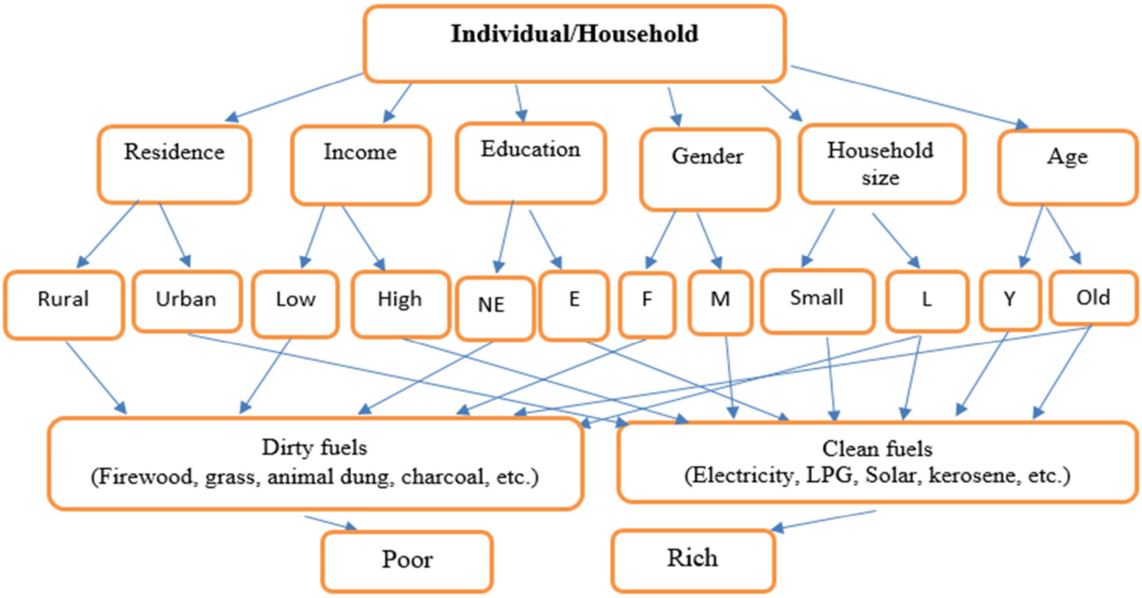
an individual or household from a rural area, mostly have limited or no access to clean fuel and have more access to dirty fuels as against what their urban counterparts will have. A low income individual or household are more likely to consume dirty fuels than their counterparts who are high income earners. An educated individual or household are most likely to be rich and can afford to consume clean fuels than their counterparts who have no formal educated.



Note: E=educated, NE=not educated, F=female, M=male, L=large, Y=young
Source: Author's construction based on literature reviewed
Figure 2: Energy-Poverty Nexus with socioeconomic characteristics

Also, a male individual or male headed household are most likely to adopt clean fuels than female individual or female headed household, partly because, most males are economic powerful than females. Smaller homes are more likely to consume clean fuels whereas larger households may consume both clean and dirty fuels depending on the need basis. It is assumed that because an individual or household is poor, it consumes dirty fuel which intend exacerbates their poverty because such fuels (firewood, grass, animal dung, etc.) emits toxic substance or smoke which are injurious to their health and leads to high health cost on them.

Furthermore, in figure 2, mostly in rural home, many women and children have to walk distances to gather such fuels, hence the opportunity cost of the time in gathering such fuels when considered will render them poor. Against this is clean fuel users, where such homes are mostly high income earners, in urban settings, educated and mostly smaller size who are likely to be rich and does not face risk of fuel toxic or smoke and not much time in acquiring fuels. It is concluded that, if two households such as household 'A' and 'B', where household 'A' is from rural area, with low income, not educated household, female headed, large size and old aged home is more likely to consume dirty fuel and subsequently being poor than household 'B' which is from urban area, highly educated home, high income earning home, male headed, smaller size and younger home.

Hence, this study analysis the effect of socioeconomic variables on the likelihood of household adopting different fuels for cooking at home and how such is related to poverty/wealth status of the household. Aside supply side issues on energy availability, the study posits that to study household energy consumption, six main socioeconomic characteristics are important, that is; the residence where the household stays (rural/urban), the income level of the household, educational level, gender of household head, size of the household (in terms of members) and age of household head.

4. Data and Methodology

4.1 Data

The study used the Ghana Demographic and Health Survey (GDHS) data for 2014. GDHS followed a two-stage sample design. The first stage involved selecting sample points (clusters) consisting of enumeration areas (EAs) of which a total of 427 clusters were selected. The second stage involved systematic sampling of households from a household listing operation and households to be included in the survey were randomly selected from these lists (12,831 households were selected). And 12,010 households were actually contacted for the interview and 11,835 were successfully interviewed, yielding a response rate of 99 percent. The data had some missing observations for our variables of interest, so it was adjusted to 11,366 observations which captured all the variables of interest. Dummy variables were coded 0, 1 codes. For sex of household head (0=female, 1=male), for residence where household stays (0=rural, 1=urban), for wealth status (0=poorest, 1=poorer, 2=middle, 3=richer, 4=richest), for educational level of household head (0=No formal education, 1=primary, 2=secondary, 3=higher) while size of household and age of household head are continuous variables.

4.2 Methodology

The model adopted is the multinomial logistic model as the dependent variable (type of cooking fuel used) is in categories. Households were asked to mention the cooking fuel they use most, hence, one fuel type was mentioned by each household. The estimation of the multinomial logit model is best carried out by utilizing the maximum likelihood estimation technique (Greene, 2003; Gujarati 2009). Maximum likelihood estimation technique gives parameter estimates that are asymptotically efficient, consistent and normal and the analogue of the regression t-test can be applied. Thus, in modelling this, Let P_i represent the probability of a household using a particular fuel alternative, say wood, such that the probability of not using wood is given as 1- $P_{i.}$ We do not actually observe $P_{i,}$ as Y is a latent variable, but instead we observe the outcome Y=1 if the household chooses alternative j, say wood and Y=0 if he does not, then we have the following model specification is used;

$$P_r \ Ob(Y_i = j) = \frac{e^{\beta_j X_i}}{\sum_{j=0}^{6} e^{\beta_j X_i}} \quad j = 1, 2, 3, 4, 5, 6 \qquad (1)\ for\ cooking\ purpose$$

For purposes of cooking, j=1, 2, 3,4,5,6 represents type of fuel used; electricity, LPG, charcoal, wood, Kerosene or Others (straw/shrubs/grass/agricultural crops/animal dung).

The model specified follows the assumption that the random disturbance terms are independently and identically distributed (McFadden, 1974). In such multinomial models, Judge *et al,* (1985) shows that even if the number of alternatives is increased (from 2 to 3 to 4 etc.) the odds of choosing an alternative fuel remain unchanged. Changing the assumptions about the error term changes the values of the coefficients uniformly but it does not affect the probability of an event occurring. It affects the spread of the distribution but not the proportion of the distribution above or below the threshold (Long & Freese 2001). The dependent variable is the cooking fuel choice (wood, kerosene, electricity, LPG/Natural gas, charcoal or others) with wood as base category. Estimated coefficients means a change in the logit for a one-unit change in the predictor variable with other predictor variables are held constant. Positive coefficient implies an increase and negative indicates decrease in the likelihood that a household will change to alternative fuel.

5. Results and Discussion

5.1 Descriptive Statistics and Distribution of Variables

The distribution of the variables is shown on table 1. The proportion of male headed household is twice that of female headed household and the rural urban divide is almost same (50.43% rural and 49.57% urban). Majority of the household consumes wood and charcoal (77.78%) while as little as less than 1% adopt electricity as main fuel. This indicates that Ghana is still a wood base or solid fuel base country.

Table 1: Descriptive statistics and distribution of variables

Variable	Measurement	Response	Percent	Obs.
Energy type for cooking	Main fuel use for cooking	Electricity	0.84	95
		LPG/Natural gas	20.15	2,290
		Kerosene/lignite	0.18	21
		Wood	46.56	5,292
		Charcoal	31.22	3,548
		Others	1.06	120
Sex of household head	Male	Male	66.55	7,564
	Female	Female	33.45	3,802
Residence	Residence nature of household	Rural	50.43	5,732
		Urban	49.57	5,634
Wealth status	Wealth status of household	Poorest	21.88	2,487
		Poorer	20.62	2,344
		Middle	21.48	2,441
		Richer	18.78	2,135
		Richest	17.24	1,959
Educational	Educational level of household head	No education	28.89	3,284
		Primary	14.03	1,595
		Secondary	46.75	5,314
		Higher	10.32	1,173

Note: Obs=observation Others= straw/shrubs/grass/agricultural crops/animal dung
Source: Author's computation using GDHS data 2014

On education of the household head, 46.75% has secondary education with less than 30% having not formal education. Wealth status indicates that; poorest households are 21.88% while richest households are 17.24%. At most poorer households are 42.5% and at least a richer household are 26.02%. Majority (71.1%) of the household heads have at least primary education, indicating that the households in the sample are educated in some way.

Table 2 shows the number and percentages of households according to wealth category and type of main fuel consumed for cooking. This shows that majority (61.05%) of those who use electricity as main cooking fuel are from the richest homes and as little as 1.05% are from poorest household. Meaning as one moves from poorest home to richest home they tend to adopt electricity as main fuel use for cooking. On those homes that use wood, 42.76% are from poorest home and almost 80% (i.e. 79.93%) are from at most a poorer home. For other forms of fuels (grass, animal dung, straw, etc.) consumed, almost all (i.e. 99%) of the households are from the poorest home. This pattern confirms the so called energy ladder hypothesis which was verified by other studies (Heltberg 2003; Aitken, 2007; Mekonnen and Kohlin 2008; Ogwumike *et al* 2014).

Table 2: Share of numbers and percentages of cooking fuel and wealth/poverty status of households

Type of cooking fuel	Poorest (%)	Poorer (%)	Middle (%)	Richer (%)	Richest (%)	Total (%)
Electricity	1 (1.05)	0 (0.00)	12 (12.63)	24 (25.26)	58 (61.05)	95 (100)
LPG/Natural gas	8 (0.35)	20 (0.87)	167 (7.29)	616 (26.90)	1,479 (64.59)	2,290 (100)
Kerosene/Lignite	3 (14.29)	5 (23.81)	2 (9.52)	5 (23.81)	6 (28.57)	21 (100)
Charcoal	113 (3.18)	336 (9.47)	1,322 (37.26)	1,365 (38.47)	412 (11.61)	3,548 (100)
Wood	2,263 (42.76)	1,967 (37.17)	934 (17.65)	124 (2.34)	4 (0.08)	5,292 (100)
Others*	99 (82.50)	16 (13.33)	4 (3.33)	1 (0.83)	0 (0.00)	120 (100)
Total (%)	**2,487 (21.88)**	**2,344 (20.62)**	**2,441 (21.48)**	**2,135 (18.78)**	**1,959 (17.24)**	**11,366 (100)**

Note: Percentages are within brackets * straw/shrubs/grass/agricultural crops/animal dung
Source: Author's Compilation using GDHS data 2014

5.2 Econometric results

Econometric results are shown on table 3. The coefficients are marginal effects at representative values (MER), which takes in to account the odds ratio, the coefficients are shown as marginal changes in the probability of using the various fuels for cooking for continuous variables and the discrete change in the probability for dummy variables. On the table, all the variables are significant in determining LPG usage. As one ages, it reduces the probabilities of adopting electricity by 0.01%, LPG by 0.1% and increases the probabilities of using wood by 0.11% and charcoal by 0.02%. A household from urban area has an increase of 6.2% in the likelihood of adopting LPG compared to a household from rural area. If the household head has at least primary education, it increases the probability of using LPG by 4.1% compared to a household without any formal education. A female headed household has 3.2% increases in the chance of using charcoal than a male headed household. These findings are in conformity with other studies (Aitken 2007; Mekonnen & Kohlin 2008; Kwakwa & Wiafe 2013).

On wealth status and fuel adoption, table 3 further shows that, a richer household has increases in the probabilities of adopting charcoal by 67.6%, LPG by 13% and electricity by 0.1% compared to a poorest household. The likelihood of a richer home to adopt wood reduces by 76.3% as compared to a poorest home. Generally, a high status home (Middle, Richer & Richest) have an increase in the probabilities of adopting clean fuels (electricity, LPG, etc.) than a poorest home. Similarly, such homes (middle, richer & richest) have a reduction in the likelihood of using dirty fuels (wood, other fuels, etc.) compared to poorest household. This suggest that, energy adoption depends on wealth (income) status. Wealthier homes adopt, most often, clean fuels than poorest households. Hence, energy-poverty nexus is one where energy and poverty are related and in a circular way.

Table 3: MER values from regression of fuels on wealth and other variables

Explanatory Variable	Electricity	LPG / Natural Gas	Charcoal	Wood	Kerosene/ Lignite	Others
Sex of Household	-0.003***	-0.013**	0.0324***	-0.019**	-0.001	0.003
Head (Female)	(0.001)	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)
Age of	-0.0001*	-0.001***	0.0002	0.0011***	0.0001	0.000
Household Head	(0.000)	(0.00)	(0.00)	(0.00)	(0.000)	(0.00)
Size of	-0.0003*	-0.014***	0.001	0.013***	-0.0002	0.000
Household	(0.00)	(0.001)	(0.00)	(0.00)	(0.000)	(0.00)
Residence	-0.001	0.062***	-0.17***	0.11***	-0.004	0.002
(Urban)	(0.001)	(0.01)	(0.011)	(0.01)	(0.003)	(0.00)
Educational level	0.001*	0.041***	-0.04***	-0.004	0.0006	-0.001
of Household	(0.00)	(0.003)	(0.01)	(0.00)	(0.001)	(0.00)
Head (Primary)						
Wealth Status of Household						
Poorest			Base category			
Poorer	-0.0002	0.002	0.157***	-0.123***	0.0004	-0.036***
	(0.00)	(0.00)	(0.02)	(0.02)	(0.003)	(0.01)
Middle	0.001	0.023***	0.558***	-0.538***	-0.003	-0.041***
	(0.00)	(0.003)	(0.02)	(0.02)	(0.003)	(0.01)
Richer	0.001*	0.13***	0.676***	-0.763***	-0.002	-0.042***
	(0.00)	(0.01)	(0.02)	(0.02)	(0.003)	(0.013)
Richest	0.0043**	0.568***	0.288***	-0.818***	0.001	-0.043***
	(0.002)	(0.02)	(0.02)	(0.02)	(0.004)	(0.013)
Pseudo R^2			0.4533			
Prob>Chi^2			0.0000			
Log likelihood			-7094.7952			
Observations			11,366			

Note: The standard errors are within brackets; (***), (**), (*) significant at 1%; 5% and 10% levels. Others= straw/shrubs/grass/agricultural crops/animal dung. **Source:** Author's estimation

6. Conclusions

This study looked at the debate over energy-poverty nexus of how household energy consumption and poverty are related. Wealth status and household energy adoption indicates that, wealth is a full determinant of the type of energy household adopts for cooking purposes. The results show that majority (61.05%) of those who use electricity as main cooking fuel are from the richest homes and as little as 1.05% are from poorest household. Meaning as one moves from poorest home to richest home they tend to adopt electricity as main fuel use for cooking, and the likelihood of a richer home to adopt wood reduces by 76.3% as compared to a poorest home. This confirms the energy ladder hypothesis and is an indication that energy and level of poverty are related.

Other variables such as the age of household head, sex of household head, educational level of household head, residence where household stays and the size of household were found to have influence on the energy adoption behaviour of household, a household from urban area has an increase of 6.2% in the likelihood of adopting LPG compared to a household from rural area and female headed household has 3.2% increases in the chance of using charcoal than a male headed household. Household head with at least primary education has an increased in the probability of using LPG by 4.1% compared to a household without any formal education. As one ages, the probability of adopting electricity and LPG as main fuels reduces and the probability of adopting wood, charcoal and other fuels increases.

Efforts to reduce general poverty should be geared towards, but not limited to, the making of clean fuels available to households and individuals. Poverty reduction strategies should include means of provision or motivating the use of clean fuels by households. Further studies should look at the issue in a cross country case and other case scenarios where they look at both cooking and lighting. Also, attention should be drawn to multiple fuel usage, since households adopts more than one fuel based on different reasons. The data used for this study only dealt with where the household respondents were asked to mention the fuel type they use most.

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